

An Analysis of Fish and Amphibian Distributions in Lentic Environments of Lassen Volcanic NP

By

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ABSTRACT:

Amphibians are top predators in montane wetlands of Lassen Volcanic National Park (LAVO). The Cascades frog (*Rana cascadae*) has undergone steep population declines and is believed to be at immediate risk of extirpation in the park (Fellers and Drost 1993). Inventories in the mid 1990s noted only one remaining population in the park (Fellers, unpublished data). The status of other native pond-dwelling amphibians is presently unknown, but regional declines in many species have occurred over the last 10-15 years (Sparling et al. 2001). Introduced fish are believed to be a potential factor in the decline of the Cascades frog and other native amphibians in the park (Fellers and Drost 1993). This study proposes to conduct an integrated field study to evaluate relationships between fish and amphibians. It will also provide a quantitative baseline and recommendations for amphibian conservation and restoration in LAVO.

Justifications

BACKGROUND

Lassen Volcanic National Park (LAVO) comprises approximately 200 square miles of high elevation volcanic terrain in northeast California. Although the park was established to protect the unique geological features surrounding Lassen Peak, it contains the most extensive ungrazed landscape of high elevation lakes, wetlands, and meadows in northeast California. This pristine landscape forms the southern terminus of the range of the Cascades frog (*Rana cascadae*) and also supports populations of the long-toed salamander (*Ambystoma macrodactylum*), rough skinned newt (*Taricha granulosa*), Pacific tree frog (*Pseudacris regilla*), and western toad (*Bufo boreas*). The montane lakes in LAVO and adjacent US Forest Service Wilderness lands may comprise an biographically distinct island of high elevation aquatic habitat between the uplands of the Cascades, Klamath Mountains, and Sierra Nevada. Moreover, since LAVO occupies the southern range extremity for the Cascades frog, it is an ideal location to evaluate the ecology and persistence of amphibian populations at its range margin.

Amphibians are typically the top native vertebrate predators in many lakes and ponds of the Sierra Nevada and Cascades Range, where pleistocene glaciation prevented fish from colonizing most lakes higher than ca.1500-1800 meters in elevation. With the arrival of Euro-Americans in the late 1800's, various salmonids (primarily *Oncorhynchus*, *Salmo*, and *Salvelinus* spp.) were introduced to high-elevation lakes. This practice was expanded in the early 1900's when the California Department of Fish and Game (CDFG) began to manage high lake stocking procedures. Routine fish stocking ceased in Lassen Volcanic National Park in the

early 1990's, but relict breeding populations of fish remain in some of the lakes. Managers desire information to help conserve and possibly restore native amphibian populations in the park. Fellers and Drost (1993) suggested that introduced fish may be an important factor contributing to declines noted in populations of the Cascades frog in LAVO, but current information on fish and amphibian distributions are lacking.

PROBLEM STATEMENT

Although other factors such as pollution, climate change, or other factors may also be operating (Bury 1999, Sparling et al. 2001), growing evidence suggests salmonid fishes have quantifiably detrimental impacts on native amphibians (Knapp and Matthews 2000, Larson and Hoffman 2002, Bull and Marx 2002). Working with the mountain yellow-legged frog (*Rana muscosa*) and several other amphibian species in high elevation lakes of the Sierra Nevada, Knapp et al. (2001) demonstrated that amphibian communities show low resistance to fish presence, but substantial ability to recover when fish populations were removed or died off naturally. The findings of Knapp et al. (2001) suggest that, compared with other factors affecting amphibian populations, the effects of introduced salmonids fish is both substantial and potentially reversible.

In montane environments, simultaneous analyses of fish and amphibians have been invaluable, demonstrating that fish can substantially reduce native amphibian abundances. In a recent study ~~of salamander larvae in~~ of montane lakes of Mount Rainier National Park with and without fish, Larson and Hoffman (2002) demonstrated that fish were associated with lower abundances of salamander larvae. Although they noted that behavioral changes may have been responsible for some of the differences in recorded abundance, the presence of fish appeared to have a significant negative effect on salamanders. Similarly, Knapp and Matthews (2000) noted that fish had a substantial negative effect on populations of mountain yellow-legged frog (*Rana muscosa*) in the Sierra Nevada. Preliminary analyses of the 1999-2000 data collected by Dr. Hartwell Welsh for the Trinity Alps of California indicate a significant relationship between the presence of introduced salmonid fishes and the absence of several species of amphibians (Welsh and Boiano. In Prep.).

Based on a study by Fellers and Drost (1993) and subsequent surveys (Fellers, unpublished data), park managers believe populations of the Cascades frog are at immediate risk of extirpation at LAVO and other native amphibians may be threatened. A simultaneous analysis of salmonid fish and amphibian distributions in LAVO would provide an essential information base for conservation and restoration planning for native amphibians in the park.

OBJECTIVES

This project has three major objectives:

- 1) To inventory and record the distribution and abundance of native amphibians and fish in lake, pond and wet meadow habitats of LAVO.
- 2) To scientifically evaluate the relationships between fish and amphibians in the park
- 3) To provide an information base to guide future park management efforts, including restoration of amphibian populations.

METHODS AND APPROACH

Amphibian and fish populations will be sampled in one summer field season using an integrated system derived from studies already being employed in the Sierra Nevada (Knapp and Matthews 2000), and elsewhere in northern California (Welsh and Boiano In Prep).

Fish surveys

Fish will be sampled in lakes and ponds of LAVO using visual encounter surveys and gillnets. In shallower water bodies all sampling will be conducted with visual encounter surveys. In deeper lakes (>3 m), a monofilament gill net will be deployed for 8-12 hours in addition to visual encounter surveys.

Amphibian surveys

Amphibian adults and larvae will be sampled using visual encounter surveys along lake or pond perimeters. The number of individuals in each water body will be determined using a complete perimeter survey. Amphibian densities will be determined by dividing the number encountered by the shoreline perimeter. Lake perimeters will be determined using a geographic information system (GIS).

Habitat Description

We will characterize physical habitat of each water body as another factor potentially affecting amphibian and fish abundances. Physical attributes sampled will include the number of inlets and outlets, amounts of fish spawning habitat, substrate percentages of the littoral zone, lake maximum depth, and summer water temperature.

DATA ANALYSIS

We will compare amphibian abundances between lakes with and without fish and for deep and shallow lakes using nonparametric Analysis of Variance. Amphibian species composition will be analyzed with Nonmetric Multidimensional Scaling (NMS) to determine variation in the amphibian community structure across gradients in fish abundance and physical characteristics. Environmental data for lake with and without fish will be tabulated and statistical summaries prepared. Amphibian and fish species distributions will be analyzed, summarized, and archived using geographic information system technology.

DELIVERABLES

This study will explicitly explore the relationship between introduced fish and native amphibians in lakes and ponds of LAVO. Specific products of the study will include: (1) a final report summarizing the project and its key findings; (2) a detailed digital map of species distributions, and a tabulation of physical and biological characteristics for each lake and pond compiled on a

CD-ROM; (3) specific recommendations for fish removal, amphibian introductions, or other management activities; (4) peer-reviewed, published scientific papers as appropriate.

2003

Pre-project Scoping and Data Summary	5,000
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Fish Inventory	15,000
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2004

Amphibian Inventory	30,000
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Data Entry and Analysis	8,000
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Study Scoping and Design	Total
Salaries	
P.I. 0	
Staff	13000
Staff Benefits	2500
Travel	1000
Supplies	800
Direct Costs	17300
Indirect Costs@15%	2595
Subtotal 03	19895

2004 Fish and Amphibian Field Inventory

P.I. 0	
Field Staff	22000
Staff Benefits	4000
Travel	3000
Supplies	1000
Direct Costs	30000
Indirect Costs@15%	4500
Subtotal 04	34500

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RANKING CRITERIA

1. Significance of the Resource or Issue to the Park

Amphibians are an essential element of aquatic biodiversity in montane environments of Lassen Volcanic National Park and in other parks with montane lakes and wetlands (Larson and Hoffman 2002). Amphibians are typically the top native vertebrate predators and may comprise the majority of biomass in montane lakes, streams, and wetlands (Larson and Hoffman 2002). This study will provide current information on the distributions of sensitive amphibian species as well as provide information on fish abundance and distributions in the park.

In addition, since amphibian declines are occurring throughout the Pacific Northwest and California, any quantitative study which helps to disentangle the factors affecting montane amphibian populations will contribute to the body of science about regional amphibian declines. Consequently, it will help scientists and managers in other parks to better understand the possible factors influencing their amphibian populations, as well as to grasp the inevitable regional variation in such relationships. Findings from a study of fish and amphibians at Lassen Volcanic will have immediate value for both conservation and restoration within the park and region-wide.

2. Severity of Resource Threat, Problem, or Needs

Recorded declines in the Cascades frog (*Rana cascadae*) in LAVO (Fellers and Drost 1993) have demonstrated that park populations are at immediate risk of extirpation. It is unknown how many frogs remain in the park and the species' prospect for recovery. Abundances and population trajectories for other amphibian species are even less well known. Conservation and restoration of native amphibians in the park will require quantitative information on relationships between amphibian populations and the factors believed to be responsible for local and regional declines. This study will play an important role by determining the effect of the most likely direct, local control on amphibian abundance, impacts of introduced fish.

Allied efforts are already underway to better understand to build the necessary scientific basis for amphibian conservation in the park. Drs. Gary Fellers and Don Sparling have been studying the effects of organic pollutants on amphibian populations in the park as part of a regional study. In addition, Dr. Hart Welsh of the USFS Pacific Southwest Research Station (Arcata, CA) has been conducting a study of fish and frog populations across the Klamath Region, and he has collected information on fish and frog abundances in wilderness areas surrounding the park.

3. Problem Definition and Information Base

Past inventories (Fellers and Drost 1993) provide a quantitative background to analyze interactions between fish and frogs in LAVO. In addition, this work will tie in with and borrow from Dr. Hart Welsh's regional database of fish and amphibian distributions in lentic habitats in the Klamath Region. Over the last three years, Dr. Welsh has conducted extensive inventories of amphibians in montane wetlands in wilderness areas of northern California. His voluminous database will provide an important background and perspective for evaluating the patterns observed in LAVO.

4. Technical Soundness

The proposed inventory is based on a study currently being conducted by Dr. Welsh throughout the Klamath Region and is derived from the sampling protocol employed by Dr. Roland Knapp in the Sierra Nevada (Knapp and Matthews 2000, Knapp et al. 2001). Similar statistical techniques for comparing lake with and without fish have also been used successfully in Mount Rainier National Park (Larson and Hoffman 2002). The approach will provide high quality data for both park management and to allow the park to participate in regional investigations into the causes of amphibian declines. Park staff are consulting with Drs. Welsh, Knapp, and Larson to ensure that the final design is robust and consistent with other studies underway in the region.

5. Problem Resolution

This project will directly address the effects of introduced fish the most obvious, measurable, and potentially reversible factor potentially contributing to amphibian declines in Lassen Volcanic National Park. In addition, it will provide an information base from which to determine the feasibility of restoring populations of the Cascades frog in LAVO. By developing maps, and quantitative databases of species distributions of fish and amphibian populations, this project will greatly improve the information base for park management of amphibians as a whole. Park staff will be well poised to evaluate restoration potential of the park amphibian populations, including location of sources populations and potential lakes or wetlands with suitable habitat. As an additional benefit, park staff will have heretofore unavailable information on the species and distributions of the native and non-native fishes encountered.

6. Transferability

Park staff are actively consulting with researchers in the Sierra Nevada (Drs. Roland Knapp, Gary Fellers) , the Klamath Region (Dr. Hart Welsh), and in the Cascades (Drs. Gary Larson, Bruce Bury, and Michael Adams). Findings at Lassen will be compared with Dr. Welsh's regional database for wilderness areas across the Klamath Region compiled over the last five years. The project will both contribute to and benefit from the regional inferences possible from such a large-scale, design-based study. The project will allow park and forest service managers to begin a discussion and partnership to address amphibian issues in far northern California. In addition, important information and protocols developed or refined in this project will be communicated broadly through publication in the scientific literature.

7. Cost Effectiveness

This project has been designed to be efficient and to borrow heavily from existing protocols developed by the USDA Forest Service and work in the Sierra Nevada. The primary costs will be seasonal field staff, data management, and some project oversight by the principle investigator. Daniel Sarr, Klamath Inventory and Monitoring Coordinator, will provide joint project management.

8. Project Support

The Klamath I & M program will provide temporary housing and other logistical support to field personnel. The proposed project integrates nicely with Inventory and Monitoring efforts in the park. Lassen has not had a formal inventory of its lentic fish populations. A joint study of fish and amphibian populations would serve both the parks need for a basic fish inventory and the need for an ecological study of fish/amphibian interactions. Park and Network staff are committed to this project and USGS partners (Drs. Gary Fellers, Gary Larson, and Bruce Bury) are also informed and supportive.

Measurable Results

Lassen's 2002 General Management Plan includes in its vision statement for the preferred alternative these statements: "Lassen Volcanic National Park is a model for ecosystem management, wilderness preservation and cultural resource protection. Park resources are passed on unimpaired for the benefit of present and future generations" and "Scientifically sound mechanisms are in place to ensure that natural systems and processes are perpetuated." Actions needed to meet this vision are listed in the GMP and include knowledge of park resources, including parkwide inventory and monitoring activities.

Lassen's 2002 Annual Performance Plan includes goal: Ib01 -- By September 30, 2003, species of concern are monitored on a periodic basis sufficient to detect a severe population decline or health deterioration. This project will provide critical information on fish and amphibian distributions in the lentic environments of Lassen Volcanic National Park.

This study will explicitly explore the relationship between introduced fish and native amphibians in lakes and ponds of LAVO. Specific products of the study will include: (1) a final report summarizing the project and its key findings; (2) a detailed digital map of species distributions, and a tabulation of physical and biological characteristics for each lake and pond compiled on a CD-ROM; (3) specific recommendations for fish removal, amphibian introductions, or other management activities; (4) peer-reviewed, published scientific papers as appropriate.